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THE JOURNAL
OF
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OF CANADA

VOL. XXXVII, No. 10 DECEMBER, 1943 WHOLE No. 329

A MAP OF THE LUNAR CRATER CONON AND SUGGESTED WORK FOR AMATEURS

By FRANK VAUGHN

AN earlier paper by the writer[1] explains the action and possible meaning of a moving floor "cloud" in Conon, and also describes some of the dark bands to be found on the walls. This later paper is intended to extend these studies and to present a map of the crater showing marks not previously found on early lunar maps; to correct a fallacy with regard to this object; and to indicate a course of observation for future amateur work which badly needs to be done.

EARLY WORK ON CONON[2]

From Neison, page 177:

CONON (R)—A circular crater, 10.19 miles in diameter, and 6° bright, on the high Apennine plateau, from five measures by Lohrmann in plus 21° 31′ 27″ lat., and plus 1° 57′ 18″ long. Its depth is considerable, according to Schroeter, being 3450 feet, and it contains a slight central mountain, discovered by Maedler, overlooked by both Schroeter and Lohrmann.

From Elger:

CONON—A bright little crater, 11 miles in diameter, situated among the intricacies of the Apennines, s. of Mt. Bradley. It has a central hill, which is not a difficult object.

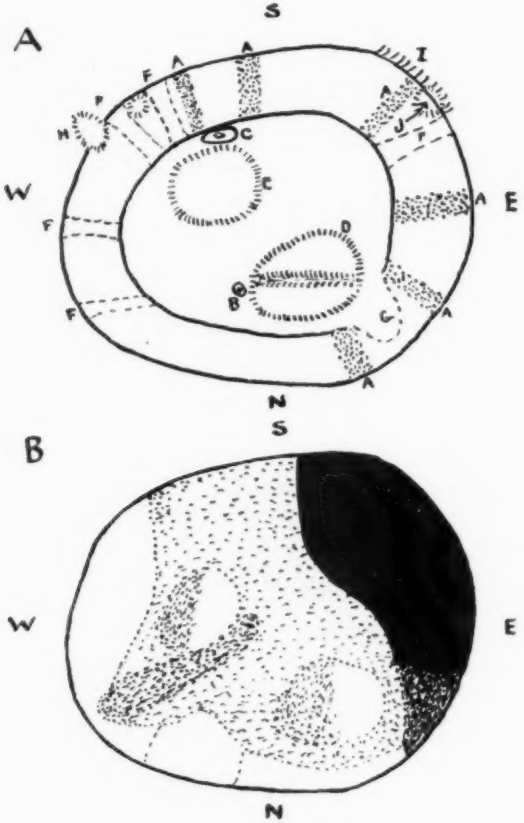
Note: Goodacre's 1936 measurement of this crater was 13 miles.

[1]This JOURNAL Feb. 1942.

[2]Material kindly given me by D. P. Barcroft.

From *Publications of the Lick Observatory*, Vol. III, 1894, by Professor L. Weinek, pp. 97-98:

In the Western Apennine highlands lie the craters Conon and Aratus. . . . Schroeter detected a central peak in Conon which was not drawn by Lohrmann, but which Maedler has represented. The Lick photographs fully verify its existence.



THE LUNAR CRATER CONON

A—A map of Conon based on the writer's work.
B—The drawing which first showed the hills as such.

Drawings by F. V. 1943

In reading the above the reader will note the confusion as to the discoverer of the so-called central mountain, and to the discrepancies in the diameter of the crater. Goodacre himself says, in his *Moon*, of Conon:

> A distinct deep crater ring in the heart of the Apennine mountains, about 15 miles in diameter, and contains a central peak.

This last seems to indicate that Goodacre took an older observer's word about the diameter, then changing his mind after he himself measured it.

Recent Determinations of the Diameter of Conon

Walter H. Haas, using the Flower 18-inch refractor with a micrometer, found a diameter for the crater of 13.17 miles, plus or minus .11 miles.

The writer measured Mount Wilson photographs, using a magnifier, and a .01-inch scale, and as the average of a large number of measurements arrived at a diameter of 13.35 miles. The average of our two separate results yields something near 13.3 miles with a probable small margin of error.

The "Central Mountain" of Conon

The following is composed of later observational work on the crater, along with two possible explanations of the "central mountain" seen by some of the older observers *which certainly does not exist today*.

Pickering[3] in 1920 denies the existence of any central peak in Conon, as a result of his own observations under extremely favourable conditions, and with a good telescope; better than most of the older workers had. Haas and the writer have many times observed this crater very carefully under good conditions, and some of the time with better instrumental equipment than was available to Pickering, and while noting much finer detail in the crater than was seen by previous observers, no evidence of a central elevation was even suspected.

What is the meaning of this discrepancy? Has the "central mountain" disappeared since the early work was done, or were the

[3] *Popular Astronomy*, July-August 1920.

observers guilty of poor or hasty work? The writer is inclined to think neither. These names have too long been identified with skill and care; Neison, Maedler, Elger, etc., and last, and perhaps most important of all, Goodacre. The probabilities lie in the direction of misidentification with the "cloud", which at some colongitudes is very prominent, and the writer thinks it not difficult to imagine that this mark could easily be misinterpreted for a bill, especially without critical and continued study. Photographs show the "cloud" very well at some colongitudes, if good, but certainly show no other detail on the floor. The Mt. Wilson photographs of 1938, kindly sent me by Joy, show this feature well, as do several of Pickering's in his *Photographic Atlas*. This, in conjunction with Weinek's statement about the Lick photos, which I have not seen (but which can hardly be superior to the Mt. Wilson photos), and with the visual work of Haas and the writer, would strongly point to the misidentification theory of the "central mountain".

A Map of Conon

(A) of the accompanying figure is a map of Conon based on the writer's work, and is subject to much improvement and revision as no micrometrical measures of the details were made. In regard to the two hills shown on the floor, their position is only approximate as they are very faint and difficult objects, even at favourable colongitudes.

(B) is the drawing which first showed the hills to the writer as Such. This drawing was made with a 9-inch reflector under good conditions of atmosphere, using 280 diameters, at colongitude 148°. It shows a dark floor area developing in the west, and the waning "cloud" nearly gone into the northwest wall. Incidentally, the "cloud" is usually gone sometime before this colongitude.

An explanation of the map follows:

(*a*) are the darkish wall bands seen nearly all lunation long, and which seem to be permanent topographical features, though they vary in intensity as the lunation progresses.

(*b*) is a tiny crater, hardly a mile in diameter, but of fair depth.

(*c*) is a very shallow depression, and a difficult object, though larger than (*b*).

(*d*) is the low n.e. hill, which is ***probably*** crossed by a low ravine e.w. The writer has only seen the western half of the hill favourably enough to see the valley, but from its regularity, it is not improbable that it continues across. Confirmation would be desirable.

(*e*) the s.w. hill is the smaller of the two, and an extremely difficult object.

(*f*) are passes in the wall, though in no case a complete breaking away of the rampart. They are merely sharp low points.

(*g*) is a portion of the inside wall broken away, though complete at the rim.

(*h*) is a high peak entering the wall, and appears to be the highest point in the crater. Another small and inconspicuous peak lies to the s.e.

(*i*) is the highest part of the wall except for the preceding object, and appears fairly smooth.

(*j*) is a peak of medium size.

The writer hopes that the foregoing will be sufficient to convince many that the moon is by no means a barren field, and that much remains to be done, even in mapping the surface. A large number of observers, each working on small areas could accomplish much toward increasing the knowledge of our satellite.

1581 Berkshire Road,
Columbus, Ohio
October 9, 1943

THE OCCULTATION OF JUPITER ON JANUARY 13, 1944

By R. M. Petrie and Jean K. McDonald

During the course of its monthly circuit of the heavens the moon passes close to many bright stars and planets and from time to time moves directly in front of a star or planet. The star is seen to disappear instantaneously as the moon's eastern limb cuts across the stellar beam and, about one hour later, the star reappears suddenly at the western limb of the moon. Such phenomena are called occultations and during a year occultations of several bright stars may be seen from any one place on the earth.

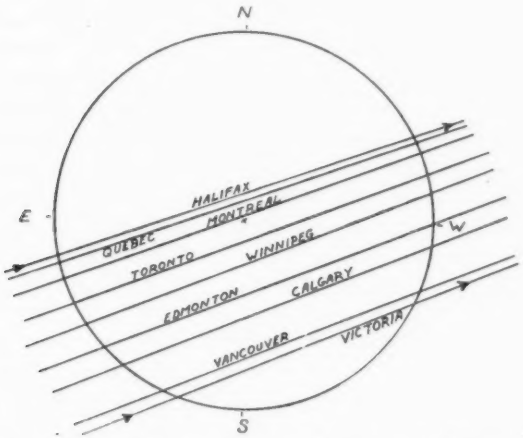
Occultations of a bright planet are much less frequent, however, and for that reason attention is drawn to the occultation of Jupiter on January 13, 1944, visible throughout Canada. As seen through a small telescope, field glasses, or even with the unaided eye, the phenomenon is one full of interest to amateur and professional astronomer alike and should not fail to be observed by all students of nature and watchers of the sky. The steady, inexorable motion of the moon toward the planet, eclipsing its disk and finally blotting it out entirely, constitutes an exciting celestial display while the reappearance of the planet at the dark, invisible, western limb of the moon is also full of interest. Incidentally it may be noted here that accurately noted times of disappearance and reappearance,

THE OCCULTATION OF JUPITER—JANUARY 13, 1944

	Disappearance		Reappearance	
	Time	Position	Time	Position
Halifax, N.S.	8h 58m A.M.	102°	9h 56m A.M.	297°
Quebec, P.Q.	7 52 "	104	8 53 "	296
Montreal, P.Q.	7 53 "	109	8 56 "	292
Toronto, Ont.	7 54 "	117	8 58 "	285
Winnipeg, Man.	6 29 "	124	7 39 "	280
Edmonton, Alta.	5 06 "	133	6 17 "	270
Calgary, Alta.	5 10 "	141	6 20 "	264
Vancouver, B.C.	4 05 "	156	5 04 "	249
Victoria, B.C.	4 08 "	160	5 03 "	245

particularly for star occultations, are of genuine scientific value since they yield the best data for studies of the motion of the moon.

The table accompanying this note gives the local circumstances of the occultation for a number of stations across Canada. These were extracted from the *Nautical Almanac* for Montreal, Toronto, Calgary and Vancouver and were computed for the other localities. The times of disappearance and reappearance are given as well as the position angle P, on the moon's limb, where the phenomenon takes place. The times are Standard *increased by one hour*, e.g. for Winnipeg they are Central Daylight Time. The times are given



Apparent Paths of Jupiter with Respect to the Moon for the Canadian Cities Indicated.

only to the nearest minute since they are calculated for the centre of Jupiter's disk. The beginning of eclipse happens about one minute before the times computed for the disappearance of the centre of the planet, and the first reappearance of Jupiter happens about one minute sooner than the reappearance of the centre of the disk. Anyone not located at one of the places in the table may estimate, from the times listed there, the approximate time for his own locality.

The occultation will occur with the moon and Jupiter in the western sky for most of the country and especially so in eastern Canada. While the disappearance will be visible generally, the reappearance will be observed under unfavorable circumstances in eastern Canada, particularly in the Maritimes, due to the low altitude of the objects. The accompanying diagram shows the apparent paths of Jupiter with respect to the moon and indicates the positions of disappearance and reappearance. It is hoped that weather conditions will permit a large number of people to enjoy this beautiful spectacle.

Victoria, B.C.
1943, November 20.

TELESCOPE, MICROSCOPE, AND BAROMETER AS A POINT OF DEPARTURE FOR THE NATURAL SCIENCES*

By Louis C. Karpinski

THE telescope, the miscroscope and the barometer connect directly with many of the most fundamental interests of man through the centuries of recorded civilization. The universe with the stars, animal and plant life, and the physical properties of air and water, occupied man's intellectual powers, largely, possibly, to be able to understand and control nature, but also to satisfy man's curiosity. Throughout history the scientific discoveries have been freely communicated from scientist to scientist, from nation to nation. Advancement was made by the cumulative effort of intelligent beings, one building upon the work of another. This is the greatest triumph of intelligence.

An illustration is the development of astronomical theory from the time of the Babylonians to Isaac Newton. The astronomical discoveries of the Babylonians and Egyptians, notably records of eclipses, were communicated to the Greeks, becoming the foundation of further progress by the Greeks. In turn this material passed on to join similar material gathered by Hindus and Arabs. The degrees and minutes and seconds of the Babylonians continue in all astronomy today. A Greek textbook in astronomy placing the earth at the centre of the universe continued in use throughout Europe until 1600 A.D. By 1543 Greek, Hindu and Arabic trigonometrical developments enabled Copernicus, a Pole, to introduce the sun as the centre of the universe, replacing gradually the Ptolemaic theory. Strangely enough only theologians seemed to be deeply concerned by this revolutionary theory. Extremely accurate observations of the stars by Tycho Brahe, a Dane, combined with a knowledge of Greek geometry of the conic sections, enabled Kepler, a German, to formulate the laws of planetary motions. The progress of mathematics, particularly algebra, enabled Galileo, an Italian, to revise ancient ideas and to formulate the correct laws of falling bodies. The new knowledge of the earth and the moon and the planets, in part due to the use of the telescope, enabled Newton in 1687 to utilize the work of Galileo, Kepler, Tycho Brahe and Copernicus to enunciate the laws of universal gravitation.

*A paper read at the Tercentenary Commemoration of the invention of the Barometer, at Toronto, October 19, 1943.

In the progress of science, accumulation of facts by observation and experiment is the first step. The human mind is able to control and dominate only a limited amount of material so that classification and systematizations in various ways are essential. With facts involving measurements or positions in space, a mathematical formulation may be possible. For observation and for measurement, instruments become necessary, while theories are necessary for control over the observations. In astronomy the observations of the movements of a planet, like Mars, were made somewhat comprehensible by the Ptolemaic theory having the earth as the centre. The more accurate observations of Tycho Brahe before 1600 could no longer be reconciled with the earth-centre theory. The Copernican theory with the sun as the centre enabled Kepler using Tycho Brahe's observations to discover the fact that the movement was not in a circle, but in an ellipse with the sun as focus.

A theory begins as an explanation of facts observed, but progress in science is largely due to the fact that correct theories suggest new discoveries and new advances, not before made by observation alone. Similarly the use of an instrument begins with one purpose in the mind of the inventor but the use of the instrument often suggests further new uses which may be made, based upon the instrument in question.

The telescope was designed for the more accurate observation of the heavenly bodies. Who would have suspected that the first use of the instrument by Galileo in 1610 would provide the means for really accurate determination of longitudes of places upon the earth's surface? The frequent eclipses of the moons of Jupiter made this possible.

The Kepler-Newton theories later involved certain positions of the planets determinable by the telescope. When observations disclosed certain incorrect positions of a planet, the theory required the presence of some disturbing body. In this way, theory enabled astronomers, an Englishman and a Frenchman, to locate the position and size of the planet Neptune, causing the disturbance, before Neptune had ever been observed. The fact that the telescope combined with the spectroscope and the microscope reveals the com-

position of the stars is another indication of the unexpected contributions of these instruments to scientific knowledge.

The discovery of wireless telegraphy and the radio is an illustration of the power of the mathematical formulation of theories. In 1819 H. C. Oersted, a Dane, discovered that an electric current creates a magnetic field around the wire deflecting a compass. In 1831 Michael Faraday demonstrated that by rotating a wire in a magnetic field, using a magnet, an electric current could be generated, the fundamental idea involved in an electric motor. Between 1862 and 1864 Clerk Maxwell formulated mathematically these reciprocal relationships, arriving at symmetrical equations similar to those for wave motion, set up in 1747 by d'Alembert. The velocity of the electrical impulses deduced from these equations developed as the velocity of light, leading to the electro-magnetic theory of light. Maxwell's mathematical theories of electricity and magnetism enabled him in 1864 to assert that electrical impulses could be produced and then distributed without wires. Hertz, a German, starting from Maxwell's assertion, constructed in 1888 a resonator for the detection of wireless waves. The coherer was discovered in 1890. It was the mathematical equations which really made the coherer possible.

Instruments serve another most important purpose in attracting the attention of large groups of people and in making it possible also to explain to larger groups by these tangible devices which help to clarify the theories. In this way also more students are drawn into scientific work; progress requires workers in the given field.

In 1608, the year in which Torricelli was born, a Dutch glass worker was given a license to construct and sell a combination of lenses for making distant objects appear near. In England Thomas Digges stated in 1571 that his father, Leonard Digges, had had such an instrument but the instrument was not described. Dutch telescopes began to be used in Germany and in England in 1609. Galileo received information in that year concerning the device and immediately began constructing successful telescopes, soon far exceeding any magnification then achieved elsewhere. On March 13, 1610, Galileo published his "Heavenly Messenger" (*Sidereus nuncius*), announcing the discovery with his "eye-glass" of the moons of Jupiter, the composition of the milky way as formed by millions of stars and star

clusters, and also the mountainous character of the surface of the moon. So impressed was an English official in Florence that he sent on that day a communication to the Earl of Salisbury, requesting him to inform the King of the publication and the discoveries.

An early copy of the book was sent to Kepler who immediately prepared and published an edition in Prague with appreciative notes. The telescope was baptized in Italy with this name, and Galileo used the word in 1611. The instrument had the most enthusiastic and wide-spread publicity that had ever been accorded a scientific invention. As Professor Marjorie Nicolson has recently shown, major and minor literary men throughout the world explained or made reference to the new discoveries. Doubtless some of the limited interest aroused by the fundamental astronomical discoveries of Copernicus and Kepler did stimulate the enthusiastic reception of the new details concerning planets, the stars, and the moon's surface given by the telescope. At the same time larger groups were introduced to the new fundamental theories of the heavenly bodies.

Galileo very quickly learned to adapt the compound lenses to the construction of compound microscopes. Apparently telescopes, microscopes, and even spectacles were sometimes sold by the laboratories under both Galileo and his successor, Torricelli. By 1625 the microscope was quite well known in Italy. In Holland and in England optical workers soon constructed such microscopes. Nevertheless the wonders of the microscopic world were not revealed until the third quarter of the seventeenth century. In England the greatest interest was aroused by the experiments made before the Royal Society by the Curator, Robert Hooke, beginning in 1663. In 1665 Hooke published his "Micrographia" and in the remarkable drawings of his observations gave the first definite representation of the cellular structure of cork.

However, it remained for a Dutchman, Anthony von Leeuwenhoek, employing a simple magnifying glass of his own grinding and construction, to introduce microscopic life to medical science with accurate descriptions of protozoa and bacteria. Leeuwenhoek was a man of genius, with unusually acute vision coupled with extraordinary powers of observation. His vivid descriptions of the minute animal life and the extraordinarily accurate drawings made under his direc-

tion aroused the deep interest of leading scientists of Europe. A combination of a clear glass biconvex, single lens (less than ¼ inch in diameter), carefully ground and mounted between two oblong metal plates, with some system of lighting, which, combined with an effective movable mount, enabled observations that could not be equalled by compound microscopes for nearly a century. Fortunately early experiments of Leeuwenhoek attracted the attention of a Dutch physician who was in correspondence with Henry Oldenburg, Secretary of the Royal Society of London. Through this source in 1673 the Royal Society published in the *Philosophical Transactions,* in translation, notable extracts of observations of parts of the mouth, the eye, and the sting of the bee, with drawings, particularly of the most impressive organ of the bee, the sting. The following year Leeuwenhoek communicated to the Society the discovery of "very little animalicules" in fresh water, giving the first notice of direct observations of protozoa. During 1675 the energetic Dutchman made extensive studies of protozoa and bacteria, continuing intensively these studies for a full year before reporting to the Society in a letter of 17½ folio pages, dated Oct. 9, 1676, and published in part in translation in the *Transactions* (Vol. XII, No. 133, pp. 821-831). With these recorded observations begins real microbiology, the sciences of protozoology and of bacteriology. In 1675 also the red corpuscles of the blood were observed. Leeuwenhoek's researches continued to be reported for full fifty years in the *Transactions* of the Royal Society.

Three men, trained as physicians but with wide interests in plant and animal life, were able, in the same period in which Robert Hooke and Leeuwenhoek worked, to use the compound microscope to advance the sciences of botany, zoology and medicine. Marcello Malpighi in Italy observed (1664) the structure of the lung and the circulation of the blood in a frog. This Italian's fine work on the anatomy of plants in 1671 was followed within a year by that of Nehemiah Grew, discoverer of sexuality in plants. Embryological studies "on the chick in the egg" made by Malpighi continued work begun by Dr. William Harvey. Jan Swammerdam (1637-1680) in Holland, an expert in microscope technique as applied to insects, laid the foundation for the scientific classification of insects. These men prepared the way for the modern medicine and biology of the eighteenth century in

which the compound microscope attains somewhat general use by students.

It is in the vacuum and in the air that the barometer of Torricelli makes contact with the natural sciences. The creation of the barometer was the direct result of studies connected with the vacuum and with the weight of the air. When the barometer was created this led to the invention of the air pump and to studies upon the composition of the air.

Galileo, who introduced into Italy both the telescope and the compound microscope, was also directly responsible for suggesting the problems which led Torricelli to the invention of the barometer. In Galileo's major work on physics, his *Two New Sciences*, published in 1638, three different and separate discussions are given which when combined in the mind of Torricelli resulted in the barometer. In the first of these at the beginning of the *Two New Sciences,* Galileo discusses the unsolved problem indicated by the common phrase, "nature abhors a vacuum." Galileo gives "the force of the vacuum" created in a pump as equal to the weight of a column of water 33 feet high of the same cross-section as the bore of the pump. At this height the pump fails and the water falls. The second discussion, much later in the work, concerns the weight of air which by experiment he found to be 1/400 that of an equal volume of water. With this Galileo coupled discussions of the true weight of a given volume of sand *in a vacuum*. No one at this time knew how to create a vacuum, but Galileo does not hesitate to assume a vacuum. In a third section Galileo discusses in connection with falling bodies the resistance of the air and of water and, generally, of "different fluid media." This treatment of the air as a fluid undoubtedly had great influence in the correct solution of the "force of the vacuum" problem by Torricelli. The pressure of water had been studied extensively from the time of Archimedes in his studies of floating bodies; the greatest advance had been made by Simon Stevin of Bruges in a publication in Dutch (Leyden, 1586), "On the pressure of water." Further advance was made by considering these different speculations simultaneously. Not only falling bodies but also projectiles were studied by Galileo who was the first to state that the arc of flight of a bullet, neglecting the resistance of the air, is a parabola.

Torricelli visited Galileo in Florence in 1641, bringing to his attention studies on falling bodies and projectiles, and tables made as a continuation of Galileo's work on projectiles. Early in 1642 Galileo died and shortly thereafter Torricelli was elected to succeed him. The unsolved problem of the "force of the vacuum" was brought to Torricelli's active attention again in contemplating the resistance of the air in his own study of projectiles. This work was in 1643 being prepared for publication, appearing in Torricelli's *Opera Geometrica* printed in Florence in 1644.

"Towards the end of 1643," we are informed by a contemporary, "Torricelli having speculated upon the reason [for the failure of the pump], had suddenly come upon the difficulty and its solution. Considering . . . what Galileo had written . . . that the water in the pump . . . would not lift itself above about 32 feet, passing which limit it pulled away, leaving void the rest of the space above . . . he conceived that quicksilver, so much heavier than water, placed in a cylinder of glass, could by a simple operation be used to form a vacuum in a space much smaller than would be necessary using water. He thought then of making a glass tube 4 feet long, one end terminating in an empty glass ball and the other end open. This tube when completely filled with mercury, placing the finger on the open end . . . could be reversed, submerging the end under the level of mercury in a vessel; removing the finger the mercury would detach itself from the ball (top), and would drop lower, remaining suspended, according to his calculations, at about the height of 30 inches, leaving in a part of the tube a space verily to be considered a vacuum."

"Torricelli communicated this reasoning to his friend Vincenzo Viviani who, anxious to see the operation, soon had the instrument made and, procuring quicksilver, was the first to make this noble experiment, and to see the effect foretold by Torricelli."

Torricelli repeated the experiment many times and attempted also to place living animals in the vacuum formed. This did not result very decisively as the mercury through which the animals passed to reach the vacuum had a bad effect upon the animals, viz., a fish, flies and a butterfly, used to test the effect on life, sound, and flying.

In a letter written June 11 of 1644 Torricelli described the barometer in detail to Michael Angelo Ricci in Rome, by whom this and

a second letter (below) were communicated through Francesco de Verdus to Father Marino Mersenne, a correspondent of many learned men, living in Paris. Later in 1644 Mersenne came to Florence and Torricelli performed the barometer experiment for him. This fact is mentioned by Mersenne in a publication of 1647.

In the first letter to Ricci, Torricelli states the following points:

(1) "A certain physical experiment was being performed on the vacuum, not simply to produce a vacuum but to make an instrument that would show the changes in the air, which is at times heavier and thicker, and at times lighter and more rarefied . . . Many have said that a vacuum cannot be produced . . . I know of no one who has said it can be produced without effort and without resistance on the part of nature."

(2) "The cause which I have proposed is, namely, the weight of the air."

(3) "We live submerged at the bottom of an ocean of the element which by indisputable experiments is known to have weight . . . near the surface of the earth where it is most dense it weighs about the four-hundredth part that of water (of equal volume)."

(4) "Those who have written about twilight have observed that the vaporous and visible air rises above us about fifty or fifty-four miles; I do not believe its height is as great as this, since if it were I could show that the vacuum would have to offer much greater resistance than it does—even though . . . the weight referred to by Galileo applies to the air in very low places . . . whereas that on the tops of high mountains begins to be distinctly rare and of much less weight than the four-hundredth part of the weight of water."

(5) "To show that the tube is perfectly empty, the underlying basin was half filled with mercury, and half with water . . . and the tube was slowly raised. When the mouth of the tube reached the water one could see the quicksilver fall from the neck, whereupon with a violent impetus the tube was completely filled with the water."

(6) "On the surface of the liquid in the basin there presses the weight of fifty miles of air."

(7) "Water similarly in a much taller tube would rise to a height of 33 feet, that is, as much higher than the quicksilver as the quicksilver is heavier than the water."

This point is crucial in Torricelli's argument which connects the pressure of the 33 feet of water, in Galileo's pump, with the equal weight per unit of height of a column of mercury, and with the equal weight (or pressure) also per unit of area of the total column of air.

(8) Using two tubes, one with a plain top not enlarged and one with a spherical ball at the top, Torricelli notes, "if there were any interior force due to the vacuum, it would be greater in the larger vacuum. However, the mercury remains at the same height in both tubes; the force holding both must be external and the same."

(9) Finally Torricelli says that the chief purpose which was to determine "when the air was thicker and heavier and when it was more rarefied and light" failed because the level of the mercury varied also appreciably with the heat and cold "almost as if the tube were filled with air."

In replying June 28, 1644, to questions by Ricci, Torricelli notes that "the mercury in the tube and vessel is not really in air or water or glass, but it is a balanced liquid, one surface bounded by a vacuum or near vacuum exerting no pressure, and the other (in the vessel) bounded by air pressed by many miles of air piled up; therefore the surface not under pressure rises, driven by the other, until the weight of the metal raised equals the weight of the air pressing on the other side."

A second type of experiment is indicated in which a foot of mercury balances the pressure of almost 14 feet of water. The mercury is placed in a U-tube, one branch of which is 15 feet longer than the other, the mercury standing at a height of about a foot in each tube. The U-tube is put in a tank of water with the open end of the longer branch out of the water and the water presses only on the mercury in the shorter tube at a depth of about 14 feet; the pressure of the 14 feet of water raises the mercury in the longer tube 1 foot higher than the level of mercury in the shorter one.

Had Torricelli published in his *Opera Geometrica*, which appeared in 1644, a brief mention of his new instrument, with the points mentioned in the two letters to Ricci, no dispute with other physicists could have arisen. Torricelli had clearly indicated that the pressure of air was the real cause for the action and the failure of the pump. Torricelli indicates the connections with Galileo's "force of the

vacuum," and with the weight of the air as determined by Galileo and the arguments connected with that determination.

In 1646 Pascal performed in France the Torricelli barometer experiment, using water and also red wine, and a tube over 40 feet long; the experiment using mercury was performed in Poland by an Italian, Valeriano Magni. In printed documents these were mentioned as the earliest demonstrations. Despite the fact that Pascal had read the argument of the first letter to Ricci, of which he cites a page, naming it as an Italian experiment, in his *New Experiments Touching the Vacuum,* yet nowhere in this work does he mention Torricelli's name, or the pressure of the air. Pascal cites Mersenne as the source of his information about the Italian experiment. Pascal's second work on this subject, in 1648, concerns taking barometer readings on a mountain, at the bottom, the middle, and on top. The book is entitled, *Account of the Great Experiment on the Equilibrium of Liquids,* in which the proof of the pressure of the air is asserted to rest on the mountain experiment. Descartes claimed that he had suggested to Pascal this experiment to be made on the Puy-de-Dome. However, Torricelli himself twice mentions in the Ricci letters the lighter character of the air "on the tops of high mountains . . . of much less weight than the four-hundredth part of the weight of water." This weight is given, also, following Galileo, noting "near the surface of the earth where it is most dense." The experiment on the mountain only verified known facts mentioned by Torricelli. Neither Descartes nor Pascal had anything but a minor part in establishing the force, the pressure of the air as Torricelli proved, that sustains the mercury.

Torricelli was one of the men who used the "method of indivisibles" commonly associated with the name of a contemporary Italian mathematician, Cavalieri. When Torricelli states that he could prove that if the atmosphere were fifty miles high the pressure would be greater than that of 33 feet of water, undoubtedly Torricelli had in mind a proof using the method of indivisibles which is analogous to the modern integral calculus method. However, the necessary postulates which had to be made were not stated. No indication is found of his proposed method.

A celebrated voyager-scientist, Monconys, who made journeys to note scientific developments in many lands, states that in 1647 Tor-

ricelli was working on liquid thermometers, to replace inadequate air thermometers in use, and upon condensation hygrometers. Both types of instruments were necessary to complete "the chief purpose" of the barometer which Torricelli had in mind. Undoubtedly had Torricelli lived he would likely have published some account of the barometer with indications of the determination of the part of the temperature and the saturation of the air in barometric readings.

Ten years after Torricelli's death in 1647 a German, Otto Guericke, familiar with Torricelli's vacuum, devised a pump to enable one to make vacuum chambers, having the pressure of the air within these chambers approach very closely to that of a vacuum. This method was published by the physicist, Gaspar Schott, in Herbipoli in 1657. When Robert Boyle in England began his notable researches on air and then on other gases, he improved greatly Guericke's pump and made modifications of some Torricellian devices to establish Boyle's law which states that, the temperature being maintained the same, the pressure to which any given volume of gas is subjected multiplied by the volume remains a constant value. Boyle's experiments undoubtedly contributed much to the discovery of different gases, leading finally to fundamental facts concerning the nature of all matter.

How different the use which was made of the Torricelli material by Robert Boyle and by Pascal. To Boyle was suggested by the various tube devices of Torricelli, another experiment to confine with mercury and subject to varying pressures a given amount of air in the closed part of a U-tube. This air will be under ordinary atmospheric pressure when the mercury in the open tube and in the closed tube are at the same level. Let us say the pressure is at 30 inches. Now adding mercury to the tall open tube until it stands 30 inches higher than the level of the mercury in the closed tube, the air was found to be reduced to one-half its original volume; the pressure was doubled since, to the normal air pressure equal to 30 inches of mercury, was added the pressure of another 30 inches of mercury. By tripling the pressure, taking care to keep the temperature the same, the volume of the air was reduced to one-third. Boyle established the law, true within certain limits, that with a given quantity of gas at

constant temperature under varying pressure the product of the volume by the pressure is constant.

Of the men whose instruments we have briefly discussed, Galileo and Torricelli made contributions which could readily be adapted for instruction. Their work became through their students a part of the majestic progress of science from age to age. The development of astronomy coupled with the telescope, and the developments of physics coupled with the barometer and air and water pressure, were natural continuations of these sciences as they had developed through centuries.

In the case of Leeuwenhoek's discovery of protozoa and bacteria, the instrument used was not readily adaptable for instruction purposes. The medical sciences were not quite prepared for these revelations of microorganisms. Despite the participation of the Royal Society in making the discoveries known, the full import of this material was not realized for much more than a century. When the material again was systematically studied, the medical sciences, botany, and zoology, were modernized; the men who accomplished the revolution were men with fundamental training in these sciences who recognized the place in the life sciences of the animals and structures observed.

What made the instruments mentioned of importance is the fact that scores and even thousands of students were enabled to observe, with more understanding, fundamental processes of nature. The democratic growth of the groups who could observe led to larger numbers of devotees of the sciences. So the cycle of progress continued.

In the new world the first recorded observations with the telescope appear to be those made in Hartford, Connecticut, by John Winthrop, Jr., in 1665. Winthrop, the first American to be made a Fellow of the Royal Society of London, reported to a member of that Society that he had made observations of the four moons of Jupiter, noting that there was apparent trace of a fifth moon. Winthrop's telescope was presented to Harvard in 1671. The actual discovery of the fifth moon is credited to Dr. E. E. Barnard, an astronomer of the nineteenth century who made a series of observations establishing definitely the

existence of the body. It could not have been seen with Winthrop's telescope.

Worthy of particular note are the observations in November, 1680, made of Halley's comet by a Harvard astronomer Thomas Brattle which were duly credited as Boston observations by Isaac Newton in the *Principia* of 1687. Yale University's representative in England in 1714 received from Newton gifts of the second edition of the *Principia* and his *Optics*; these are to-day on the shelves of Yale University Library.

The earliest real compound microscope arrived at Yale in the year 1734. At Harvard a shipment of instruments in 1732 made by the great benefactor of Harvard, the English merchant Thomas Hollis, included two celestial spheres and a microscope with a condensing lens, but not strictly a compound microscope.

Popular lectures on science in America were begun in 1726 by the first Harvard Professor of Mathematics, Isaac Greenwood. These lectures, outside the regular curriculum, were given in 1726, *An Experimental Course of Mechanical Philosophy*. There were sixteen lectures. In the outline the statement is made of the first lecture . . . "in this Lecture is shown by proper machines, that there are *de facto* interspersed vacuities in Nature . . . *Quantity* is Infinitely Divisible, and in Natural Bodies the Parts are so prodigiously minute as to exceed all Imagination." Another similar series of lectures in 1731 states for the first lecture, "Of the Essential Properties of Space and Natural Bodies. Lecture I. Of Extension—The Manner of *Conceiving* and real *Proof* of a Vacuum, by several *Curious Experiments*." As Greenwood had attended in England the lectures by the physicist Desaguliers he was familiar with the barometer, then the active subject of many papers in the scientific journals of England, France and Italy.

The obligations of national scientific organizations to popularize science has long been recognized, particularly in England with the Kensington Museum and lectures at the Royal Institution by the greatest physicists, even to audiences of children. The obligation, also, to place the benefits of modern science increasingly at the service of the public presses upon us as we observe that for destructive purposes the accumulated resources of the nations in science have been

enlisted to the utmost. When there is finally a peace table one may hope that scientific organizations and educational institutions such as the participating organizations in this meeting, may have a part to include wider opportunities for democratic education and general participation in the advancements of modern science which represent so completely the highest aspirations of men as thinking beings working together throughout the ages past.

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University of Michigan.

THE AMERICAN ASTRONOMICAL SOCIETY*

By Dean B. McLaughlin
Secretary

THE American Astronomical Society had its inception in the First Conference of Astronomers and Astrophysicists which was held October 18-20, 1897, in conjunction with the dedication of the Yerkes Observatory, at Williams Bay, Wis. The program was so successful that it was decided to hold a meeting the next summer. The second conference was held at the Harvard College Observatory, August 18-20, 1898, just preceding the Boston meeting of the A.A.A.S. At that conference it was resolved that such meetings be continued, and a committee was appointed to make plans for them. This committee, consisting of George E. Hale, Simon Newcomb, Edward C. Pickering, E. W. Morley, and G. C. Comstock, recommended the formation of a permanent society. A special meeting for preliminary organization was held at Massachusetts Institute of Technology, August 23, 1898. The committee, designated as "Executive Council," was enlarged by the addition of S. P. Langley, Lewis Boss, A. A. Michelson, and J. S. Ames, and was given authority to draw up a constitution.

The Executive Council prepared the constitution and bylaws at a meeting February 18, 1899, at the Smithsonian Institution, and accepted the invitation of Dr. Hale to hold the next conference at the Yerkes Observatory. This third conference, now known as the first meeting of the Society, was held September 6-8, 1899. The constitution was adopted, the first election of officers was held, and the organization of the "Astronomical and Astrophysical Society of America," as it was then called, was completed.

In 1914, by constitutional amendments, the name of the organization was changed to "The American Astronomical Society," as it is now known. In 1928 the Society was incorporated under the laws of the State of Illinois, and its official home was designated as the Dearborn Observatory, Northwestern University, Evanston, Ill.

In the earlier years, meetings were held annually, usually in the

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late summer. Since 1920 there have been two meetings each year, one in summer and the other near the end of December. The summer meeting is still the annual meeting at which the regular business of the Society is transacted and its officers are elected. The meetings are usually held at an observatory, university, or college to which the Society has been invited. Programs have consisted mainly of papers submitted by members, but on several occasions symposia have been held which consisted of invited papers on selected topics.

Membership is open to any person "deemed capable of preparing an acceptable paper on astronomy, astrophysics, or related branch of physics." Annual dues are $3. One may become a life member by paying an amount which is a function of his age. All members in good standing receive the *Publications* of the Society at no additional cost and may subscribe to the *Astronomical Journal* and the *Astrophysical Journal* at reduced rates.

The Council of the Society may elect to honorary membership one eminent foreign astronomer at each annual meeting. In all, 17 honorary members have been elected.

At the time of its organization, the Society had a membership of 113. Several of the original members are still living and active. The membership at the end of 1942 was 637.

The governing body of the Society is a Council, composed of the president, two vice-presidents, secretary, treasurer, nine councillors, and two ex-presidents.

To date, 10 astronomers have held the office of president:

Simon Newcomb	1899-1905
Edward C. Pickering	1905-1919
Frank Schlesinger	1919-1922
W. W. Campbell	1922-1925
G. C. Comstock	1925-1928
Ernest W. Brown	1928-1931
Walter S. Adams	1931-1934
Henry Norris Russell	1934-1937
Robert G. Aitken	1937-1940
Joel Stebbins	1940-1943

In 1933, Dr. Annie J. Cannon established, through a gift to the Society of a sum of money, a prize to be awarded at intervals of

three years to women who have made outstanding contributions to atsronomical research. The three recipients, to date, are:

Cecilia Payne-Gaposchkin	1934
Charlotte Moore Sitterly	1937
Julie M. Vinter Hansen	1940

The Society has issued nine complete volumes of its *Publications*, which contain abstracts of papers presented at the meetings, as well as annual reports of many American observatories. With the completion of the current Vol. 10, this series will be discontinued, and the material which formerly appeared therein will be published in the *Astronomical Journal.*

The *Astronomical Journal* was acquired by the Society in 1941, after it had been published for many years at the Dudley Observatory, Albany, N.Y. The Council of the Society appoints the editor and three associate editors of the *Journal.* The present editor is Dr. Dirk Brouwer, of Yale University Observatory.

The Society also collaborates with the University of Chicago in the publication of the *Astrophysical Journal.* The agreement of collaboration was signed in 1941, and the Council of the Society nominates nine collaborating editors.

To date it appears that astronomers can best contribute to the war effort by their individual activities in teaching navigation, physics, or mathematics, and in research work in physical laboratories. The American Astronomical Society has sponsored two symposia on the teaching of navigation, which were held in connection with its two meetings during 1942.

The Society plans to continue the holding of meetings, at least annual meetings, though probably on a much reduced scale, during the period of the war. It is believed that the continued exchange of ideas, both in pure science and in the war-time applications of astronomy, will justify such continuation.

ON REVOLUTION AND ROTATION

By Hugh M. Johnson

THE words "revolution" and "rotation" and those derived from or allied with them stand for notions long and widely used in certain of the exact sciences such as physics and astronomy. They are indeed fundamental concepts for these studies, yet it is interesting how seldom they are defined where they are needed. A dictionary definition makes them partially synonymous in according to each too indefinitely something like "motion around a center or axis," and it is evident that they are interchanged in common parlance in the sense of motion. For technical purposes a distinction should be required, but the student of astronomy, for example, usually has nothing more to go on than his intuitive understanding hinged on some particular dictum, such as "a planet rotates on its axis and revolves around the sun."

To understand better these forms of motion we first concede that all motion exists in variation in the ratios of distances separating a set of not less than three positions. We note that the positions may be called points in an imaginary system and the same as necessary geometric abstraction in application to nature, leaving distance undefined except as the idea of a set of more than one point implies the notion of distance. Naming some point the "centre" and another the "reference position", and having the ratio of distances from each unnamed point to the centre and to the reference position vary in such a way that there results for each unnamed point a course contained on the same side of its tangent plane as the centre, said point is a rotating point if the centre may be grouped with it under an independent classification, or is a revolving point if such an independent classification is unassigned. But, as we have seen that abstraction into points is always possible, independent classification is arbitrary and so is the term rotation. It is a convenience, to be applied to a thing with characteristics besides motion and for that reason more easily considered as a whole of some kind, the independent classification, than as abstract points. It is of interest to notice that

in nature, when opportune, rotation is usually applied to bodies the physical elements or, ultimately, abstracted points of which are united under the bonds of cohesion, while revolution is reserved for bodies, each abstracted to a single point, considered in one system under the inscrutable liaison of gravity.

The preceding paragraph describes revolution and rotation in the most general way: around a centre. Motion around an axis requires a considerable particularization. Each unnamed point must be contained in a plane, generally distinct, perpendicular to the axis, nominally straight, at a distance from the centre, contained in the axis, making a constant ratio with the distance between the centre and the reference position; in nature an abstraction to this effect may be made.

126 Albemarle Street, Rochester, New York
October 23, 1943.

THIRTY-SECOND ANNUAL MEETING OF THE A.A.V.S.O.

Owing to war-time conditions the usual spring meeting was omitted but the 32nd Annual Meeting of the American Association of Variable Star Observers was held at Harvard Observatory, Cambridge, Mass., October 8 and 9, upon the invitation of Dr. Harlow Shapley, Director. Since the majority of the Harvard astronomical staff are absent on war work the scientific programme was slightly modified but the attendance of 60 was ahead of 1942.

On October 8 the Association was the guest of the Bond Astronomical Club. Professor B. W. Sitterly, Wesleyan University, Middletown, Conn., spoke on "The Finding of Stellar Distances". He listed four possible methods of determining the distance of a star. (1) A comparison of the apparent size with the real size. This method is nearly useless in the case of individual stars but it has been applied to globular star clusters on the assumption that these objects are all of the same order of size. (2) A comparison of the apparent and the real brightness of a star. This is now used a good deal, and includes such methods as spectral parallaxes and the determination of the distances of clusters by the apparent brightnesses of their cluster variable stars. This latter method is a powerful one and is applicable in some cases up to a distance of a million light-years, though it is most often applied to stars which are from 10,000 to 100,000 light-years distant. (3) A comparison of the apparent and the real colour of a star. This is very limited in its application and only applies if distance causes a variation in the colour of a star. The interstellar absorption of the calcium lines is a special case of this, but at present this method of determining the distance of a star is not very accurate. (4) A comparison of the apparent motion of a star with its real motion. In practice this means a determination of the relative motion of the earth and a star, but as described below only the orbital motion of the earth is considered in determining the base-line of the parallactic triangle.

When method (4) is used a star's parallax is determined from the measurement of from 20 to 40 photographs taken over a period of some years. The apparent position of the brighter star under investigation is measured against the average of all the faint field stars. Owing to the motion of the earth round the sun and the sun's motion in space the apparent path of the nearby star relative to the more distanct background stars, as measured on the series of plates, looks like a stretched spring or corkscrew. Each "coil" is caused by the orbital motion of the earth and the "stretch" is caused by the motion of the sun through interstellar space. By analysis of the photographs the "coil" motion is segregated and as this motion is dependent upon the size of the earth's orbit the star's distance is determined from the size of its "coil" or epicylic motion.

In his retiring address as President of the A.A.V.S.O., Dr. Dirk Brouwer, Director of the Yale Observatory, continued Professor Sitterly's theme by discussing the measurement of photographic plates taken for parallactic purposes. Yale Observatory, under the leadership of the late Dr. Frank Schlesinger,

Life Member of the A.A.V.S.O., has quite a tradition in astrometry. Two types of problems present themselves in the endeavour to secure accurate plates. These are (1) Problems of long-focus telescopes and (2) Problems of short-focus telescopes.

One long-focus telescope error is "magnitude error". This error is caused by poor guiding and arises in the following manner. The bright star whose parallax is being determined is, perforce, greatly overexposed on the plate, whereas the faint reference stars are usually exposed to about the right amount. Suppose the telescope is guided accurately for 90% of the time, but the remaining 10% of the time the images drift a little to one side. Under these conditions the faint stars will show sharp images, with faint imperceptible trails for the 10% of the time when the drift occurred, but the bright star will show an elongated image, for even the short exposure during the time of drift will suffice to make a fully exposed elongated trail. If the middle of this trail is taken as being the location of the bright star it will throw the apparent position of the bright star to one side with regard to the point-like images of the faint stars in the field. This "magnitude error" is overcome by decreasing the intensity of the image of the bright star on the plate. This is achieved by placing a rotating sector in front of the bright star image on the photographic plate so that the star's light is only allowed to pass through to the plate for say 10% of the time, thus producing an image of the bright star under study of the same general size on the plate as those of the fainter field stars which are fully exposed.

The second long-focus telescope error is the "hour angle effect". This is caused by atmospheric refraction which raises towards the zenith the image of a blue star more than a red star. To overcome this error successive slides in the series are made only near the meridian and at the same average hour angle.

Recently it has been found at Sproul Observatory that some photographic films after development show indications of a bodily shift sidewise of the centre portion of the photographic film of about 0.015 millimeter with regard to the outer edges of the plate. This shift does not affect the accuracy of plates which have field stars close to the brighter star whose parallax is under measurement, but the accuracy of plates upon which the field stars are out near the edges of the plate may be seriously affected. A cure for this trouble is to take two exposures with the star images close together and then to rotate the plate 180 degrees and take two more exposures. The average of all four exposures will eliminate any "plate shift error".

A fourth error is "night error" which shows up on several nights in succession. Plates taken on these nights all show the parallax star as being shifted in one direction with regard to the field stars. It is believed that this error is caused by a refractive colour error in the same direction on several nights in succession in the atmosphere.

In addition to the above recognized sources of systematic error some inexplicable errors are found in long-focus plates.

On the new large, short-focus plates taken at Johannesburg, South Africa, some errors have been found which appear to arise from the differences in focal length of different colours. To correct for these colour errors a knowledge of the spectral type and hence the colour of each star being photographed is required. Harvard is furnishing these data. Information upon the exact magnitude of each star is also important and Columbia University is providing it. With these data furnished by Harvard and Columbia, Yale is able to improve the accuracy of its star measurements.

At the business session held on October 9, Mr. Roy A. Seely, New York, N.Y., was elected president, Dr. Charles H. Smiley, Brown University, was elected 1st vice-president, and Miss Margaret Harwood, Maria Mitchell Observatory, Nantucket, Mass., was elected 2nd vice-president. Canada is now well represented in the A.A.V.S.O. for Dr. Helen S. Hogg, of the Dunlap Observatory, University of Toronto, is Senior Past President, Mr. Bert J. Topham, Toronto, is a Councillor and Mr. Seely and Mr. Rosebrugh, the president and secretary, respectively, were both born in Canada.

Dr. A. Vibert Douglas, Dean of Women, Queen's University, Kingston, Ont., President of the Royal Astronomical Society of Canada and a Life Member of the A.A.V.S.O., conveyed her best wishes to the meeting by a letter which was read by the secretary.

M. Jos. Edgar Guimont of Montreal was one of the eight amateur observers admitted to membership. M. J. L. Pouliot of Quebec City was admitted to membership at the May 1943 Council meeting.

Mr. Leon Campbell, Pickering Memorial Astronomer, Harvard, submitted his Twelfth Annual Report as Recorder of the A.A.V.S.O. The Pickering Nova Medal was awarded by the Association to Professor Bernhard H. Dawson of LaPlata as being the first to discover Nova Puppis 1942 by visual means. This nova has faded away gradually from 0·5 magnitude to about the 8th magnitude. Unfortunately there seems to be a systematic error in the observations made by the northern observers who consistently reported it at the 6th magnitude in March and April 1943, while southern observers, who were more favourably placed, found that it was fading gradually during this time to the 7th magnitude.

During the year 31,205 observations were received, bringing the 32-year total to over 900,000. Mr. C. F. Fernald of Maine was high man with 4536 observations. The tireless efforts of Messrs. deKock and Cousins of South Africa with 3054 and 1004 observations, respectively, have made it possible to keep track of the southern variables. Seven Canadians submitted 2463 observations led by M. Paul H. Nadeau, Quebec City, with 1152 observations and followed by Messrs. Vohman, 329, Garneau, 305, Topham, 272, Duffie, 230, Labrecque, 163, and Pouliot, 11. As M. Pouliot has just been admitted to membership his start is auspicious.

All four of the R Coronae Borealis type stars have been prominent during the year, each having dropped and risen several magnitudes.

Dr. Alice H. Farnsworth, Chairman of the Occultation Committee, reported that more observers are needed in this field. Thirty-five observations made in 1943 are still unreduced, but the 45 observations made in 1942 have been reduced in duplicate and the 1941 results are ready for publication in the *Astronomical Journal*.

At the afternoon session the Seventh Merit Award was made to Mr. Charles W. Elmer who retired as Senior Past President after spending sixteen years on the Council in various capacities, during which his constant enthusiasm has been an inspiration to his fellow members. Mr. Elmer is a member of the well-known optical firm, Perkin-Elmer Corporation, Glenbrook, Conn., currently engaged in war work.

President-elect Seely and Secretary Rosebrugh reported on their joint effort, undertaken at the request of Dr. Zdenek Kopal of Harvard, to determine the times of minima of Algol. This work has been found unexpectedly difficult, but during the discussion it was concluded that a good method of determining the time of minimum is to observe the time when Algol is intermediate in brightness between Zeta Persei, mag. 2.91, and Epsilon Persei, mag. 2.96, both on the descending and ascending branches of the light-curve. Apparently about four different sets of times of minima of Algol are quoted by different authorities and no one seems to know which is most nearly correct for Algol has not been actively observed of recent years.

The Association members were the guests of Dr. and Mrs. Shapley and the Recorder at afternoon tea in the Director's residence, and the final dinner was held at the Harvard Faculty Club. At it Dr. Bart Bok of Harvard spoke on the work of the Committee for the Distribution of Astronomical Literature, Dr. Dean B. McLaughlin, Secretary of the American Astronomical Society, outlined the history of that body, and Dr. Shapley listed the astronomical highlights of the year. Among these were: Nova Puppis; the spectrophotometric work on the aurora by Farnsworth and Elvey, indicating more oxygen in the upper atmosphere than might be expected; and the important work being done to aid the war effort by astronomers. There is some evidence that spiral nebulae drag their arms behind them although the Swedish astronomers believe the arms precede. Dr. Shapley concluded his remarks by stating that he feels that pure research work will be given full opportunity to carry on in the post-war world, because the importance of basic scientific research has been shown clearly by the war needs.

D. W. Rosebrugh,
Secretary, A.A.V.S.O.

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NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Still another "Twinkle, Twinkle!"

Mr. C. A. E. Hensley of Winnipeg writes:

To the "Twinkle, Twinkle!" correspondence I contribute another version which may be more accurately remembered by other readers. It appeared in some western paper thirty years or more ago, when, for some unknown reason, I memorized it. On paper now it appears to have lost most of its metre, though it is a fairly close paraphrase of the nursery rhyme. Here it is—

Twinkle, Twinkle, Little Star!

Disseminate multitudinous scintillations, O minute sidereal atom.
My contemplative soul is distracted with mirific calculations
As to the mystery that envelopes your planetary entity.
Exalted far above terrestrial regions
And the mundane trivialities of this sublunary sphere,
You appear to my wondering gaze
Like a crystallized morsel of carbonic matter
Gleaming in the inaccessible abyss of ethereal profundity.

Congratulations to Mr. Hensley for his excellent memory.

C. A. C.

Desert Observations of Earth and Sky

In that admirable book, "The Gobi Desert" by Mildred Cable with Francesca French (London, 1942), from which a description of "singing sands" was quoted in a recent issue, are found many references to observations of the heavens and the earth. Our readers will enjoy a few examples:

The Milky Way in the Desert

In the dry desert air the sky becomes a beautiful background for the brilliant stars which hang clear, showing themselves as shining orbs and never creating the illusion of lights twinkling through holes in a curtain, as is the case in dull and murky climes. The Milky Way is not the whitish haze seen in Western skies, but like a phosphorescent shower of myriad spots of light. Night travellers are great star-gazers, and look out over an uninterrupted line of horizon to skies which are always cloudless. The clearness and watchfulness of each planet suggests a personal and friendly interest toward the wayfarer, and Venus has served as beacon to many a caravan crossing doubtful stages. (p. 107).

The Stars Never Mislead Us

How should we ever find our way across this chartless ocean of sand? The camel-driver was not afraid. He jerked the halter, which told the camel to kneel, and bade the riders take their seats. "By day we shall pick up signs," he said. "Others have gone before us, and no caravan can move without leaving some trace behind. If I miss my way, my camels will find it. At night we have the stars and they can never mislead us. Have no fear, lady, rest your heart. There will be a road." (p. 111).

Control, Order and Discipline

I had read about planets, stars and constellations, but now, as I considered them, I realized how little the books had profited me. My caravan guide taught me how to set a course by looking at one constellation, to check the progress of the night by observing the shifting position of others, to recognize the succession of morning and evening stars, and to observe the seasons by the place of Orion in the heavens. The quiet, forceful, regular progress of these mighty spheres indicated control, order and discipline. To me they spoke of the control of an ordered life and the obedience of a rectified mind which enables man, even in a world of chaos, to follow a God-appointed path with a precision and dignity which nothing can destroy. (p. 290).

Dust-spouts and Demons

However breezeless the day, somewhere on the horizon a slender spiral of sand would rise, circle, walk across the plain, leave the earth and vanish in the sky. Sometimes the whole desert floor was alive with them. At a distance they seemed insignificant, but close at hand they were fearful in their cyclonic force. Travellers call them dust-spouts from their likeness to an ocean water-spout, but the desert dweller, certain that these waterless places are peopled by *kwei* (demons), calls them dust-demons. The pillar of sand gives the impression of an invisible being daintly folding a garment of dust round its unseen form. Some whirl from left to right, and some from right to left. "This one is the male and that one the female *kwei*," said the men; "you can distinguish them by the way they fold the dust cloak around them, right to left or left to right; see how they come in pairs?

The couple came gliding across the plain in our direction, then suddenly turned aside, passing quite close, yet enveloped in such a narrow whirlwind that the curtains of the cart scarcely moved, though we saw sand and stones lifted high from the ground. A laden camel can scarcely resist the full force of a dust-spout, and when I was caught in the fringe of one, it nearly swept me off my feet.

The scientific mind of the Westerner studies the phenomenon with a view to understanding the atmospheric conditions which cause it, but the oasis man who lives and dies among desert scenes believes that waterless places are peopled by spirits who desire to be reclothed with flesh. (p. 291). C.A.C.

JUPITER'S SATELLITES I, II, III, IV, DURING 1944

Periods, for the first six months of 1944, when Jupiter's satellites will be either all East or all West. Time given is that of longitude 75° West.

1944		All	Begins at		Duration	
Jan.	1	East	5h	28m*	8h	19m
	12	West	17	26	8	57.3
	15	East	9	0	9	25
	21	East	5	29	5	51
	22	East	10	44	3	10
	24	West	1	58	0	27.1
	26	West	20	55†	13	25.2
Feb.	4	East	9h	58m**	4h	49m
	5	East	14	12*	10	59
	10	West	0	22†	17	56.4
	19	East	17	51.6*	11	49.4
Mar.	2	West	5h	34m†	18h	50m
	4	East	21	41**	12	33
	10	East	22	28.4‡	1	00.6
	16	West	9	05†	18	51
	26	East	3	26*	13	50
	30	West	12	40†	18	53
Apr.	9	East	7h	16.4m*	14h	51.6m
	20	West	18	11†	18	55
	23	East	11	07.1	1	38.2
	23	East	17	32.4	9	38.6
	30	East	13	02.4	16	41.6
May	4	West	21h	57m**	18h	56m
	14	East	16	53.1*	17	39.9
	19	West	3	13	17	32
	26	West	5	54	7	02
	28	East	20	23.8‡	17	42.2
June	9	West	11h	21m*	15h	18m
	11	West	2	08‡	0	45
	19	East	2	29.3††	17	50.7
	23	West	16	52**	13	45
	25	West	6	06*	2	14

The positions of the satellites,from Jupiter out, will be 1 II III IV as noted:

* Until conjunction of I and II.
** After conjunction of I and II.
† Until conjunction of II and III.
†† After conjunction of II and III.
‡ For the full period.

In continuation of the note in this JOURNAL of December 1942, the following table gives the seventeen periods during 1944 when Jupiter will be attended by only one satellite. Time is that of longitude 75° West. It should be noted that in the 1942 article, the period of recurrence of these "one only" configurations was erroneously given as 21 months.

	1944	CONFIGURATION	BEGINS AT	ENDS AT	DURATION
1	Apr. 15	4—0—**d	8h 31m	9h 47.5m	1h 16.5m
2	22	4—0—**d	10 23	12 39	2 16
3	May 3	4—0—d*d	1 13	2 46	1 33
4	6	4—0—**d	14 10	16 26	2 16
5	10	dd*—0—4‡	3 8	5 23	2 15
6	13	**d—0—4	17 0	18 21	1 21
7	17	d*d—0—4	7 9	7 18	0 09
8	July 24	*d*—0—2	11 38	12 3.5	0 25.5
9	Nov. 9	4—0—*d*	8 41.3	9 5	0 23.7
10	12	d*d—0—4	21 44	23 18	1 34
11	16	d**—0—4	11 4	13 18	2 14
12	20	4—0—*dd	0 24	2 53	2 29
13	27	4—0—*dd	4 31	4 48	0 17
14	30	d**—0—4	16 22	16 51.6	0 29.6
15	Dec. 7	4—0—**d	18 58	19 41	0 43
16	14	d**—0—4	21 33	21 34	0 01
17	30	3—0—***	19 11.1	19 46	0 34.9

†Satellites II, I, III disappear within 8m.
Configurations.
0 represents the disc of the planet.
* signifies the satellite is occulted or eclipsed.
d " " is on the disc.

Westfield, N.J.
July 12, 1943.

CHARLES E. APGAR.

MEETINGS OF THE SOCIETY

MONTREAL CENTRE

Recording the Perseids, Evening of August 11-12.

Plans for observing the Perseids were made well in advance this year. A meeting called for Saturday, August 7th, was attended by an enthusiastic group of twenty-five members who spent an hour or more discussing arrangements and receiving preliminary instructions. The Perseids would be at their peak on the evening of August 12-13, but in deciding upon the actual night for observation local atmospheric conditions and the time of moonrise and moonset had to be taken into consideration. The full moon (Aug. 15th) would be a serious handicap. So it was decided to hold our meeting on the first clear evening of the week of August 9th.

On Monday the sky looked promising all day but clouded up shortly after sunset. Tuesday was overcast with small breaks in the clouds. At 7.30 p.m. on Wednesday it was raining heavily but the barometer was rising and Mr. Garneau assured us that the sky would clear before midnight. Relying upon his experience we decided to call the meeting. Unfortunately several of our group, discouraged by the weather, had already made other plans for the evening, but we succeeded in rounding up a dozen people. Besides the following members of the Montreal Centre—Miss G. Lavigne, Miss I. Williamson, Messrs. Gordon Bentley, D. Douglas, J. Duffie, I. Ginsberg, C. M. Good, T. O'Sullivan, W. H. Rice and DeLisle Garneau—we were fortunate in having Miss Liliane Beaulieu, Recording Secretary of the Quebec Centre, who was in Montreal at the time, and Mr. Jacques Labrecque, another active member of the Quebec Centre with valuable practical experience.

We met at the Ville Marie Observatory as arranged but somewhat later than the appointed hour. It was nearly ten o'clock before the motley looking crowd, each attired in what he considered suitable for resisting the dampness of the early morning hours, and laden down with extra coats, deck chairs, card-table, metronome, thermos, brief cases, flashlights, etc., proceeded to the grounds of Lower Canada College. Here we were able to select a spot shielded from the glare of street lights and with an open expanse of sky.

The observers' chairs were arranged in a circle, facing outwards. In the centre was a table for the recorder and timekeeper whose equipment consisted of a carefully shielded flashlight, a metronome, meteor record sheets and a watch set to Dominion Observatory time. Each observer was provided with a star map on which to plot the meteors seen by him. Profiting by the experience of the previous year we used heavy cardboard folders to protect all record sheets from dampness.

At eleven o'clock we were ready to begin but it was ten minutes before the word "Time!" rang out. Conditions were still far from satisfactory. The clouds had scattered but there was a heavy haze. And we could do nothing about the nearly-full moon which did not set until after 2.00 a.m. Only twenty-three meteors were recorded during the first hour, these mostly of the second magnitude. After midnight the haze lifted somewhat and more and fainter meteors were visible, but even after moonset few meteors below the fourth magnitude were recorded and most were of the second and third. By three o'clock our little party had dwindled. The six of us remaining were cold and damp but we were reluctant to leave before equalling our record of the previous year. A few sips of hot coffee revived us considerably and we agreed that in future a thermos would be part of the standard equipment of all such expeditions. By four o'clock we had recorded 246 meteors (five more than in 1942) and we decided to close up shop and go home.

Although weather conditions had been disappointing, our decision to hold the meeting on Wednesday was a fortunate one for it proved to be the only evening that week when observations were at all possible.

Mr. Garneau and Mr. A. V. Madge spent two afternoons deciphering our record charts and preparing the report to be sent in to the Dunlap Observatory. We learn from experience and we now find that it would facilitate the preparation of the final report if each observer took a fresh star map for each hour of observation and if the initial of the observer were entered on the meteor record sheet beside the meteor number. It would also save a certain amount of time and confusion if before the actual night of observation a "dress rehearsal" were held for inexperienced observers, recorders and timekeepers.

Those of us who have taken part in mteor observing find it one of the most interesting activities of our Centre and are looking forward to the next occasion.

ISABEL K. WILLIAMSON, *Recording Secretary.*

20th September 1943.

OTTAWA JUNIOR ASTRONOMICAL CLUB 1942-43

Early in May of this year a meeting of the above club held at the Dominion Observatory, brought to a close another successful year of the J.A.C. Through the courtesy of the Dominion Astronomer Mr. R. Meldrum Stewart, all meetings were held at the Observatory, and on several occasions members had an opportunity of seeing how some of the Observatory's equipment is operated. While the attendance was somewhat smaller than last year, keen interest on the part of those present made up for the slightly smaller number.

At a meeting of the local centre, R.A.S.C., held last fall, Miss Miriam S. Burland of the Observatory staff was named by the society to represent the Council and be responsible for the Junior group. She replaced F/O M. M. Thomson, now on active service as a navigation instructor with the R.C.A.F.

Continuing their active interest and giving assistance to the club were Messrs. M. V. Morwick and B. L. Bradley of the Ottawa Technical School, from whose classes many of the club members are drawn.

The meetings were somewhat similar to those of last year. The quiz contest which proved a popular feature was continued. Teams were chosen at the beginning of the season and retained throughout the year; the one captained by Kenneth Freedy being the winner.

Officers who conducted the affairs of the club were:

President: Harold Serson.
Vice-President: Kenneth Freedy.
Secretary: Donald Smellie.
Treasurer: David Brown.
Press Reporter: Donald Omen.

The following is a summary of the meetings held during the 1942-43 season:

December 1st—

Organization and election of officers.

December 15th—

Sky for December, by Miss M. S. Burland.
The Planet Mars, by Donald Smellie.
The 200-inch Dome, by Harold Serson.
The Nixon Planetarium, by Miss M. S. Burland.

January 12th—

Sky for January, by Kenneth Freedy.
Planet Saturn, by James McCook.
Planet Venus, by Kenneth Freedy.
Quiz contest conducted by Miss M. S. Burland and Mr. M. V. Morwick.
Time Service and Demonstration, by Mr. J. P. Henderson.

February 2nd—

Quiz Contest, by Miss M. S. Burland and Mr. B. L. Bradley.
The Sky for February, by David Brown.
The Science of Navigation, by Miss H. D. Burwash.
Telescopic Observations, by Kenneth Freedy.
Roof Observations, constellation study, etc.

February 23rd—

Constellations of Orion and Taurus, by Kenneth Freedy.
The Observer's Handbook, by Harold Serson.
Discussion period.
Quiz Contest, by Miss M. S. Burland and Mr. M. V. Morwick.

March 9th—

Quiz Contest, by Miss M. S. Burland and Mr. B. L. Bradley.
Constellations and Star Names, by Miss M. S. Burland.
Contest—Drawing constellations of Orion and Taurus.
Constellation of Cassiopeia, by Bill Milne.
Constellations of Canis Major and Minor, by Donald Omen.

March 23rd—

Contest—Drawing Cassiopeia, Canis Major and Minor.
The Planet Jupiter, by Gilbert Kerr.
The Photo-electric Cell and Demonstration, by Ian Smart.
Dome Observations.

April 6th—

The Spectroscope and Demonstration, by Bill Derrick.
Demonstration of Moll Microphotometer, by Miss M. S. Burland.

April 20th—

Quiz Contest, by Miss M. S. Burland and Mr. B. L. Bradley.
General Discussion and Questions.
Slides on various topics discussed.

May 4th—

Closing Meeting.
Constellation of Auriga, by Allan Candy.
The life of Dr. George Ellery Hale, by David Brown.
Quiz Contest, by Miss M. S. Burland and Mr. B. L. Bradley.
Talk on Gravity and Demonstration, by Mr. A. H. Miller.

MIRIAM S. BURLAND.

Dominion Observatory,
Ottawa.
November 1st, 1943.

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